

Automation and Robotics

5600 CNC Mill

Level 4

User Guide
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Lab-Volt®

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LAB-VOLT SYSTEMS, INC.
P.O. Box 686
Farmingdale, NJ 07727
Attention: Program Development
Phone: (908) 938-2000 or (800) LAB-VOLT
Fax: (908) 774-8573

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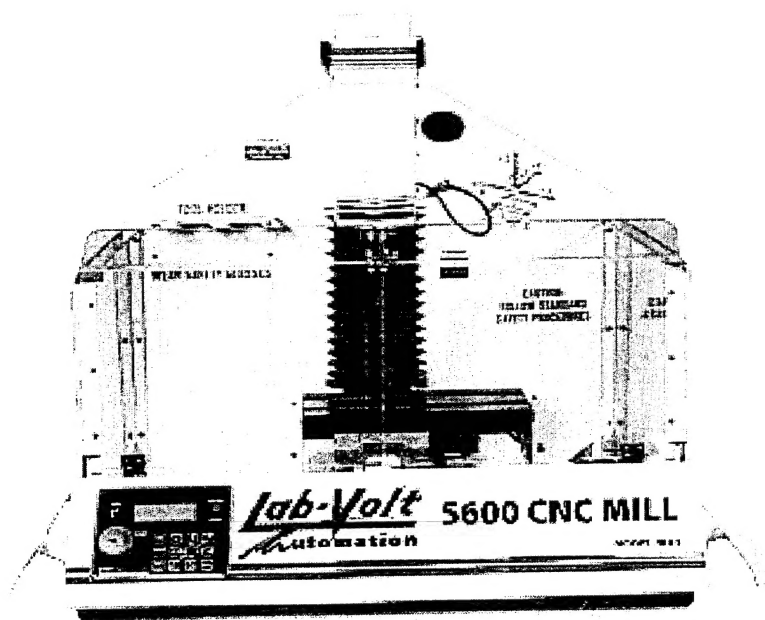
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Introduction

The Lab-Volt Automation 5600 CNC Mill is a heavy-duty, industrial grade, computer controlled milling system designed as an educational tool for training students in computer aided design (CAD), computer assisted manufacturing (CAM), and computer numerical controlled (CNC) milling. It can be used to mill small parts to programmed specifications in a variety of materials and can also be connected to robotic devices to encompass a number of computerized manufacturing processes including computer integrated manufacturing (CIM) and flexible manufacturing systems (FMS).



5600 CNC Mill

This document describes the procedures needed to install and operate the 5600 CNC Mill and the Level 4 software. It covers the following subjects:

- Setting up the mill and the Level 4 software
- Locking down a block to be milled
- Setting a programmed reference zero (PRZ)
- Selecting a part milling program
- Compiling a part program
- Viewing a part program emulation
- Milling a part with the program
- Shutting down the system
- Appendix A: Frequently asked questions
- Appendix B: Manual mode of operation

Installation

5600 CNC MILL SETUP

Specifications

Machine Dimensions

Width	38.5 in.	97.8 cm
Depth	32.0 in.	81.3 cm
Height	29.5 in.	74.9 cm
Weight	480 lb	218 kg

Feed Motors

Stepper Motors	0.9 degrees, 400 step/rev
Rapid Traverse Speed	20 in./min (51 cm/min)

Mechanical Working Range

X (longitude)	7.5 in.	19.1 cm
Y (transverse)	4.0 in.	10.2 cm
Z (vertical)	≤8.0 in. (varies with collet)	20.3 cm

Milling Table

Table Surface	5.5 in. x 12 in.	14 x 30 cm
Hold Down T slots	2	
Slot width/spacing	0.625 in./2.5 in.	1.6/6.4 cm
Maximum clearance	8.5 in.	21.6 cm

Cutting Spindle

Throat Clearance	7.5 in.	19.1 cm
Spindle Taper	R8	

Main Spindle Drive

Speed Range (continuous)	0 – 3400 rpm
Motor	3/4 hp dc

Recommended materials for milling include wax, plastic, proto-foam, and soft metals such as aluminum and brass.

Requirements

Space

The 5600 CNC Mill requires a space that will accommodate a width of 39 inches and a height of 30 inches. It also requires a depth of 34 inches plus several inches for access to the power and communications connections. The table holding the mill must support a minimum of 500 pounds.

Electrical

120 Volts AC, 60 Hz (220V/50 Hz model available)
20 Amp service

Mill Unpacking

1. Remove the packing slip attached to the shipping container.
2. Cut the straps connecting the container to the skid and open the container.
3. Remove all 5600 CNC Mill parts.
4. Examine the packing list to ensure that all parts are included. If there is a shortage, contact the Lab-Volt Systems representative.

WARNING

The mill weighs almost 500 pounds. Use appropriate means to transfer it from the shipping crate to its new location. Improper lifting can cause serious injury.

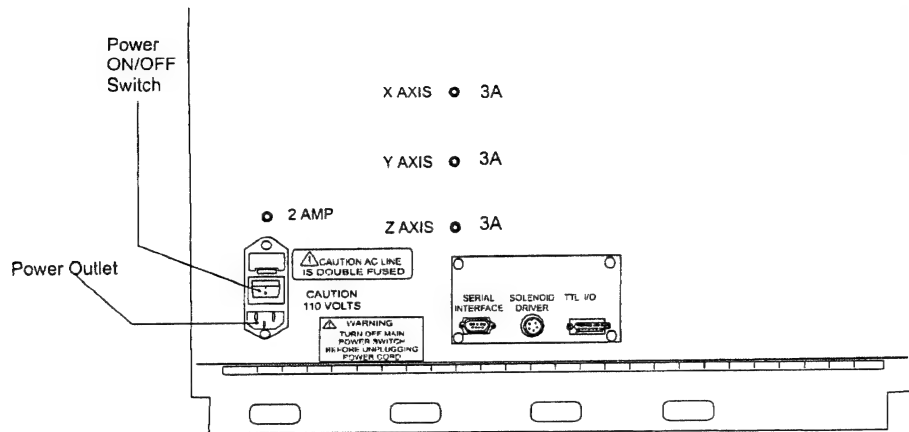
5. Place the mill on the table with the back panel exposed so that connections can be made.
6. Remove the packing material from the mill. Do *not* remove the headstock support yet.

CAUTION

Removing the headstock support can cause headstock damage that is not covered by the warranty. Do not remove the headstock support until instructed to do so.

Mill Connections and Assembly

Connections



Back Panel

Power ON/OFF Switch/Outlet – For connection to an electrical power source.

SERIAL INTERFACE port – A 9-pin port for connection to a computer.

TTL I/O port – A 15-pin port for connection to a Model 5200 Robot or for providing up to four 5-volt digital input and four 5-volt digital output lines.

SOLENOID DRIVER port – A round 5-pin port for solenoid driver connections for up to four auxiliary devices; e.g., a pneumatic vise.

1. Ensure that the power switch on the back panel is in the OFF position. The symbol "O" is depressed when the power switch is in the OFF position.

CAUTION

If the power ON/OFF switch is set to ON when the power is applied, damage can result that is not covered by the warranty. Ensure that the power ON/OFF switch is set to OFF.

2. Remove the power cable from the Accessory Pack and insert it into the power outlet under the ON/OFF switch on the back panel of the mill. Do not connect the power cable to the power source yet.
3. Remove the serial cable from the Accessory Pack and connect it to the 9-pin SERIAL INTERFACE port on the back panel of the mill.
4. Connect the other end of the serial cable to the 9-pin communications port of the computer. An adapter has been provided for a computer with a 25-pin communications port. If the connected computer has more than one communications port, note the number of the port used (COM1 or COM2, etc.). The port designation is required when setting up the Level 4 software.
5. Connect the software key to the parallel (printer) port on the computer. If a printer is connected, disconnect the printer cable first and connect it to the exposed end of the software key.

Note: *Without the software key, the software will only operate in demonstration mode.*

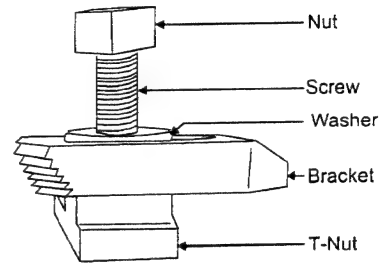
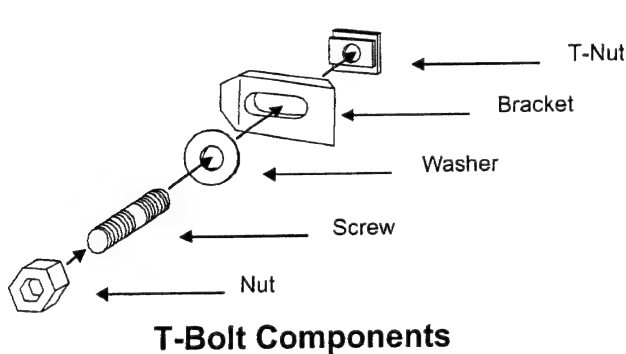
6. Connect the power cable to the power source (electrical outlet).
7. Remove the headstock support.

Removing and Installing the Mill Vise

The milling vise comes installed on the mill. This procedure is included if it must be removed – for milling larger pieces of stock, for example. Two T-bolts come with the milling vise. Each T-bolt consists of a nut, screw, washer, bracket, and T-nut.

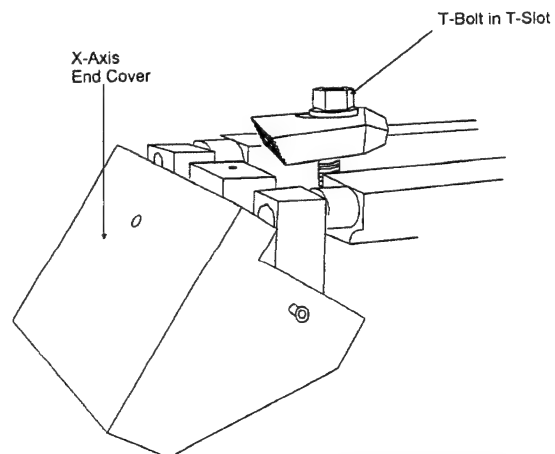
To assemble the T-bolt:

1. Put the nut on one end of the screw.
2. Slide the washer then the bracket over the other end.
3. Screw the T-nut onto the screw.



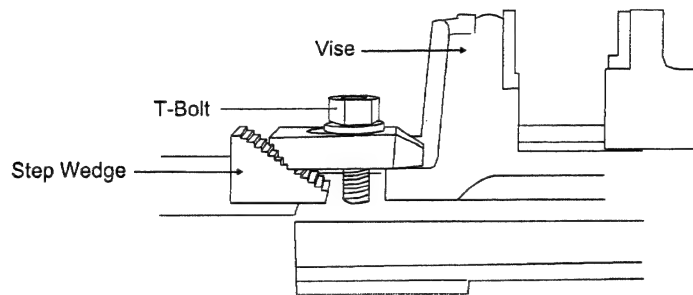
To install the T-bolt into the T-slot:

4. Using the 2.5 mm hex wrench, unscrew the top screw securing the X-axis end cover on the left side of the mill.
5. Loosen the X-axis end cover side screws just enough so that the cover can be tilted back and away from the mill table.
6. With the T-nut below and the bracket above the milling table, slide one T-bolt into each of the T-slots.



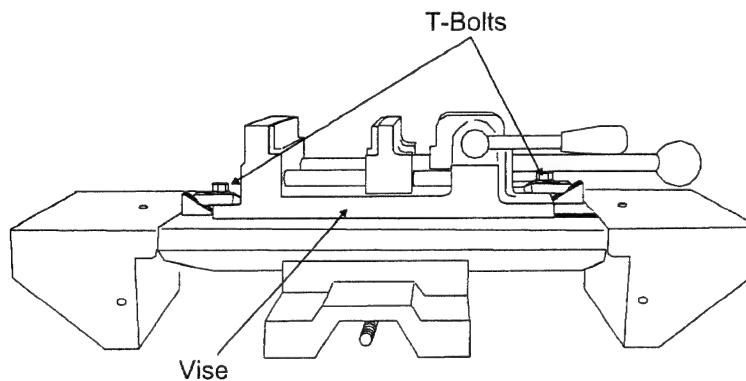
X-Axis End Cover Flipped Back

7. Place the vise on the milling table between the T-bolts. Align the vise so that it is centered over the T-slots and parallel with the front edge of the table.
8. Slide the T-bolts to either side of the vise so that the brackets are over the vise edges.
9. Push the step wedge up to the other side of the T-bolt so that the bracket is held parallel to the mill table.



Step Wedge and T-Bolt Securing Vise

10. Tighten the bolts to secure the vise to the milling table.



Installed Mill Vise

LEVEL 4 SOFTWARE

Requirements

An Intel-based or compatible computer with the following minimum features:

- 486DX-66 CPU (Pentium® class recommended)
- Windows® 95, Windows 98, or Windows NT 4.0
- 8 MB of RAM (16 MB for Windows 98 and Windows NT 4.0)
- Hard drive with 20 MB of free space
- 4X CD-ROM drive or higher
- VGA display with 256 or more colors at 640 x 480 (800 x 600 recommended)
- RS-232 serial port for communications with mill hardware
- Parallel port for the software key and for printing/plotting

Installation

1. Double click on the My Computer icon.
2. Double click on the Control Panel icon.
3. Double click on the Add/Remove Programs icon.
4. Place the Level 4 CD-ROM in the CD-ROM drive.
5. Select install. The screen "Install Program From Floppy Disk or CD-ROM" is displayed.
6. Press NEXT. The "Run Installation Program" is displayed with the command line "E:\SETUP.EXE" where "E" is the CD-ROM drive.
7. Press FINISH. After a few seconds, the Level 4 CNC "Welcome" screen is displayed.
8. Press NEXT. The "Software License Agreement" screen is displayed.
9. Press YES. The "Information" screen is displayed.
10. Press NEXT. The "Choose Destination Location" screen is displayed.
11. Press NEXT to retain the path C:\...\Lab-Volt Systems\Level 4 CNC
or
Press BROWSE to select another directory. It's suggested that you keep the designated directory.

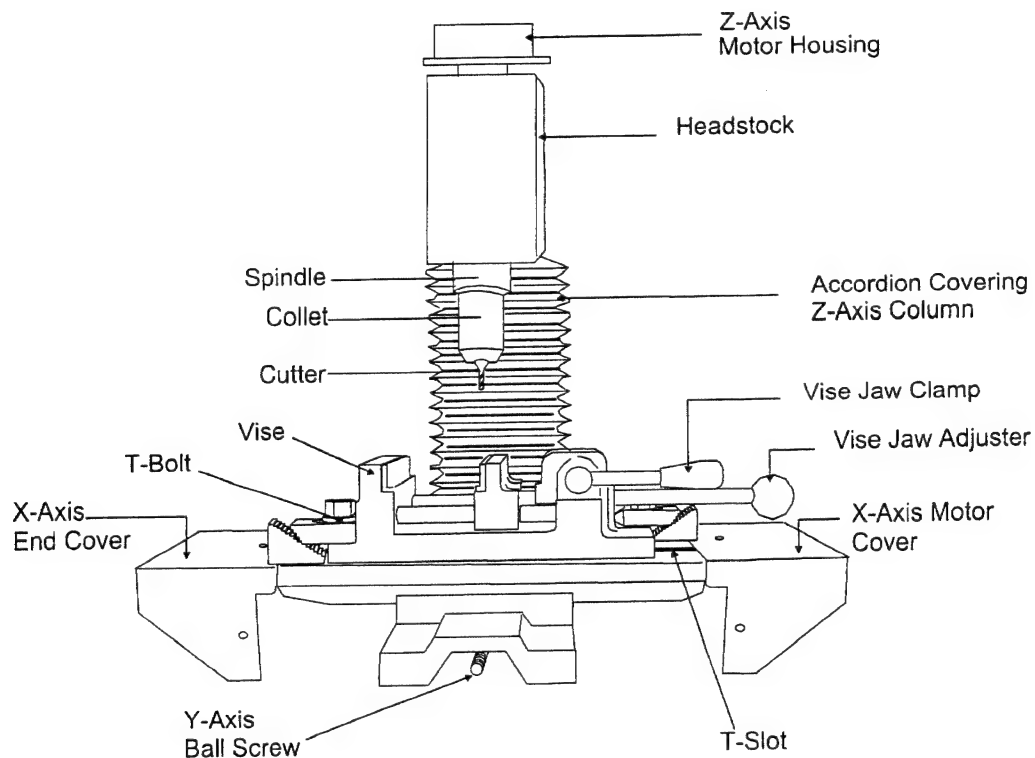
12. The "Setup Type" screen is displayed. Select the type of software to download: Custom, Lathe, Mill, Mill and Lathe, or Server. A description of each selection is displayed as the selection is highlighted. "Custom" allows selection of isolated software components and "Server" directs the installation to include the software key server for a network version of the software. Press NEXT to continue.
13. The "Select Program Folder" screen is displayed. A new folder name or a folder from the existing folder list may be selected. Click NEXT to continue.
14. The "Start Copying Files" screen is displayed. Review the settings. If they are correct, click NEXT to continue. If they are not correct, press BACK to return to the previous screen to make corrections and then continue.
15. The "Setup Complete" screen is displayed. Click FINISH to complete the setup.
16. Close the Control Panel window.
17. Close the My Computer window.

Operation

5600 CNC MILL

Functional Description

The 5600 CNC Mill is a heavy-duty, fully functional mill that can be programmed from a computer. A mill cuts both vertically (like a drill) and horizontally. The 5600 CNC Mill uses stepper motors to move the milling table along the X-axis (left and right) and the Y-axis (backward and forward). An additional stepper motor moves the headstock along the Z-axis (up and down) and a 3/4 hp dc motor drives the spindle.

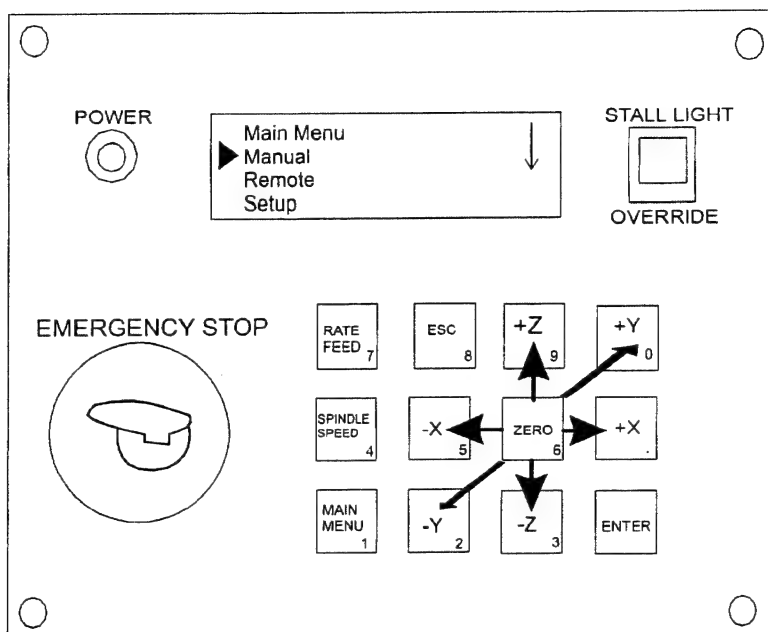


5600 CNC Mill Part Terminology

Stock to be milled can either be mounted directly on the mill table or can be secured in a vise. The CNC Mill accepts EIA-274-D standard G and M codes for mill operations. The codes can be used to create a part program, which can then be downloaded from the computer to the mill. Optionally, the mill can be operated manually using the mill control panel.

Control Panel

The control panel is located on the lower left front panel of the mill.



Control Panel

The following lights and keys are located on the control panel. The small numbers next to the keys described below are used to enter numerical values when required.

POWER LED – Indicates whether or not the power is on.

EMERGENCY STOP button – Controls the power to the spindle motor and to the stepper motors that move the milling table along the X and Y-axes and the headstock along the Z-axis. The power to the motors is cut off when the red **EMERGENCY STOP** button is pressed. It can only be released by inserting and turning the **EMERGENCY STOP** key.

FEED RATE₇ – Can be used to manually set the speed at which the mill table moves. An entry here overrides a computer-programmed feed rate. If an override occurs, an "F" is displayed in the lower right corner of the mill control panel screen.

SPINDLE SPEED₄ – Can be used to manually set the speed at which the mill cutter turns. An entry here overrides a computer-programmed

spindle speed. If an override occurs, an "S" is displayed in the lower right corner of the mill control panel screen.

MAIN MENU₁ – Pressing this key from the Remote menu returns the screen to the Main Menu. Pressing this key from the Manual or Setup menu accesses the Accessories menu.

ESC₈ – Exits the current menu or aborts a control panel operation.

-X₅ – Moves the mill table to the right along the X-axis.

-Y₂ – Moves the mill table to the back along the Y-axis.

+Z₉ – Raises the headstock away from the mill table.

Zero₆ – Sets the reference point from which the program makes all moves. From the Manual menu, pressing **Zero** followed by an axis direction key accesses the Zero Menu.

-Z₃ – Lowers the headstock towards the mill table.

+Y₀ – Moves the mill table to the front along the Y-axis.

+X₁ – Moves the mill table to the left along the X-axis.

ENTER – Selects the menu option displayed, saves any changes made, or initiates implementation of the action displayed on the screen.

STALL LIGHT OVERRIDE button – Signals the system to stop all motors. They can be restarted (after any error conditions have been cleared) by pressing the **STALL LIGHT OVERRIDE** again. Refer to the **EMERGENCY PROCEDURES** section for more details.

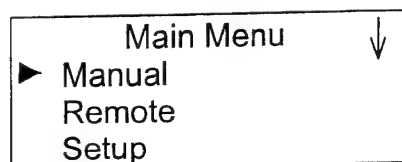
Menus

Main Menu

The Main Menu is the window for the built-in software that controls the lathe. There are five selections that can be made from the Main Menu:

Manual, Remote, Setup,

Accessories and Output. Use the Z keys to position the cursor next to a menu selection and press the **ENTER** key to select it.



Manual Menu

The Manual menu displays the feed rate of the mill table, the X and Y coordinates of the table, the Z coordinate of the headstock which holds the cutter, the current spindle

speed, the Transistor Transistor Logic (TTL) Input/Output, and solenoid status. Use this menu to operate the mill in manual mode, to manually adjust the position of the table and the headstock. The X, Y, and Z keys are only operative from the Manual menu. Use the *ESC* key to return to the Main Menu.

Man R	20.000 ipm
X 2.050	Sp 0 RPM
Y 0.072	I 1111 S 1111
Z 0.208	O 1111

Remote

The Remote selection is used to prepare the mill to receive instructions (e.g., a Level 4 part program) from an outside source. Select Remote to accept a part program download from the computer. Use the *ESC* key to return to the Main Menu.

Ready to Download

<Esc> Abort

Setup Menu

The Setup menu contains selections for distance and feed units and for keyboard beep. It allows the operator to change the units of the mill table feed (inches or

millimeters). Also, the Setup menu can be used to activate or deactivate a beep emitted when a key on the control panel keyboard is pressed and acknowledged. Use the *Z* keys to position the cursor next to a menu selection. Use the *X* keys to toggle the choice. Press the *ENTER* key to save the change and return to the Main Menu. Changes made in this way will remain until they are changed again or until the mill is turned off. To save configuration changes so that they are used the next time the mill is started, move the cursor to Save Config and press *ENTER*. To revert to the default configuration, select Reset Config and press *ENTER*. Use the *ESC* key to return to the Main Menu without saving any changes on this menu.

Setup	↓
↔ Units: inches	
Keyboard Beep: on	
Save Config	

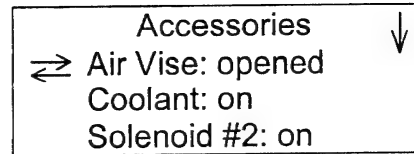
CAUTION

Factory set backlash settings are lost when the configuration is reset with Reset Config.

Accessories Menu

The Accessories menu can be used to manually change the status of the optional pneumatic vise, the coolant, and solenoids #2 and #3. Use

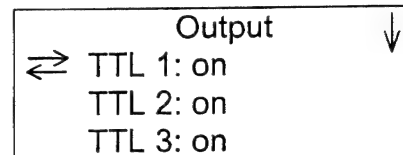
the Z keys to position the cursor next to a menu selection. Use the X keys to toggle the choice on the current line. To save changes made on this screen and return to the Main Menu, press *ENTER*. To return to the Main Menu without saving changes, press *ESC*.



Output Menu

The Output menu can be used to manually change the status of the four Transistor Transistor Logic (TTL) outputs. The TTL I/O communications capability can be used with up to four

devices. Each TTL output can be set to "on" or "off". Use the Z keys to position the cursor next to a menu selection. Use the -X or +X to toggle the choice. To save changes made on this screen and return to the Main Menu, press *ENTER*. To return to the Main Menu without saving changes, press *ESC*.



Safety Interrupts

The 5600 CNC Mill is shielded with clear Lexan® doors and is provided with several safety interrupts to ensure safe operation.

Auto Cutoff Doors

The two Lexan doors on the front of the mill are each fitted with a magnetic interlock to prevent operation of the mill when either door is not properly closed. If either door is opened during mill operation, all motors are turned off immediately.

EMERGENCY STOP Button

This button shuts off the power to all motors. After pushing this button, the system can only be restarted by using the EMERGENCY STOP button key.

STALL LIGHT OVERRIDE Button

This button interrupts the implementation of a part program by signaling the system to stop all motors. The program can be restarted by pressing the *STALL LIGHT OVERRIDE* again and clearing any error conditions.

Limit Switches

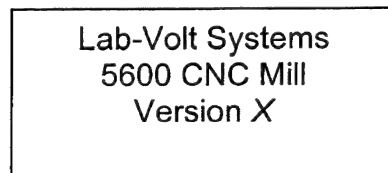
There are switches on each of the tracks that prevent the mill table and the headstock from moving past their limits. If a switch is triggered causing a lockup, return to the Main Menu, select Manual and press *ZERO*, *ESC*. Use the appropriate X, Y, or Z key to move the axis away from the limit. If the axis is still jammed, refer to **Appendix A** for further instructions. Reset the switch(es) by pressing *ESC*. This also returns the screen to the Main Menu.

If any of these buttons or switches are triggered, an error message is displayed with the option to continue or abort operations. Correct the error condition before attempting to resume operations. Refer to **Emergency Procedures** for more details.

Startup

1. Press the *EMERGENCY STOP* button.
2. Turn on the power by pressing the power switch on the left side panel of the mill to the ON position (depress the side with the “–” symbol). The *POWER* LED lights up and the *STALL LIGHT OVERRIDE* flashes.
3. Unlock the *EMERGENCY STOP* button with the key. The *STALL LIGHT OVERRIDE* stops flashing.

Wait about 60 seconds for the machine to initialize. A title screen will appear on the control panel with the instrument name and software version. If this screen is required at a later time, for instance, to view the software version, it can be called up by pressing *Zero*, *Zero*, *+Y*, *+Y* on the control panel.



5600 CNC Mill Title Screen

After 10 – 30 seconds the Main Menu will appear.

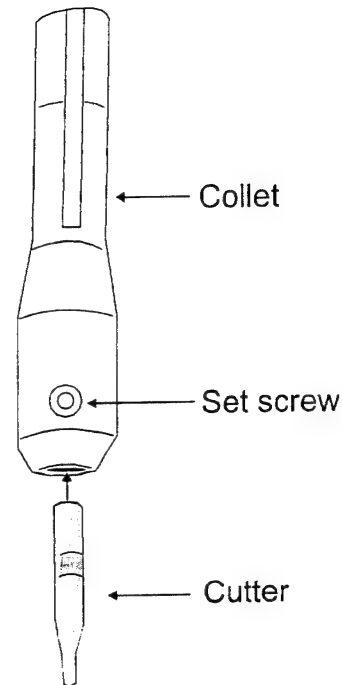
Change the Cutter

The DEMO 1 part program is designed for use with the 1/8-inch end mill cutter, which has been factory installed. To verify that the correct cutter is installed or to change the cutter, use this procedure.

If the replacement cutter has the same shaft diameter as the current cutter:

1. Use the 3/16-inch wrench provided to loosen the setscrew in the collet.
2. Remove the cutter to be replaced.
3. Make sure the setscrew is out far enough for the new cutter to be inserted. Insert the cutter so that the flat portion of the cutter shaft faces the setscrew.. While holding the cutter in place, tighten the setscrew with the 3/16-inch hex wrench to lock it in place.

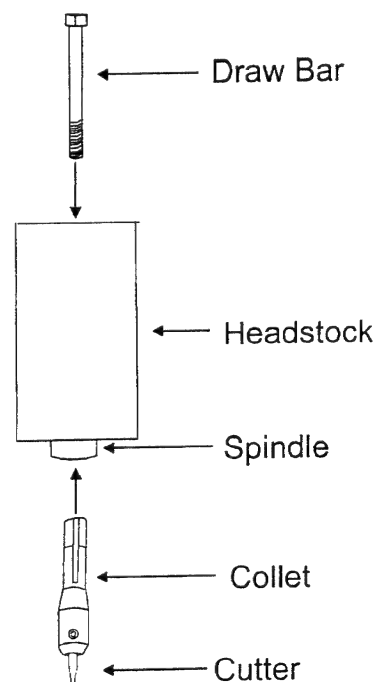
If the cutter has a shaft diameter different from the current cutter, the collet must be changed before the new bit can be installed. Refer to **Change the Collet**, then install the cutter as described above.



Change the Collet

Additional collets have been provided to accommodate different cutter shaft sizes. This procedure describes how to install a collet into the spindle.

1. Select Manual from the Main Menu. If the cursor is not next to Manual, use the Z keys to move the cursor to it. Press *ENTER* to select Manual.
2. Move the headstock to the uppermost position using the +Z button.
3. Place the 3/16-inch hex wrench in the hole on the side of the collet to keep it from turning.



4. Loosen the draw bar nut at the top of the headstock, turning it counterclockwise with the 5/8-inch wrench until the threads are no longer engaged and the bar can be lifted freely.
5. Tap the head of the drawbar to release the collet.
6. Insert the new collet in the spindle and tighten the draw bar nut by turning it clockwise.

WARNING

The end mill is very sharp. Be careful when working with it or near it.

Mount the Block to be Milled

Unwrap a block. If it is a Lexan block, remove the protective covering from the surface to be milled.

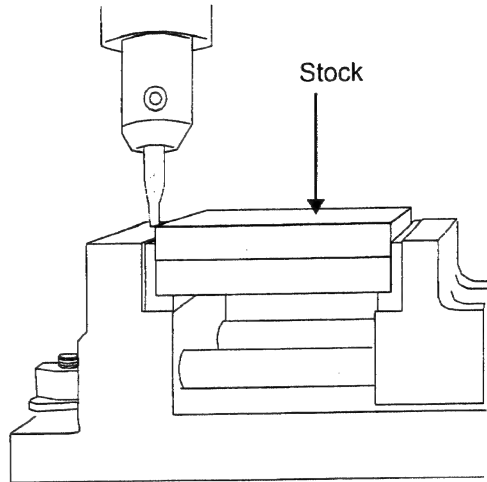
1. Pull the black-knobbed rod to open the movable jaw of the vise to the size needed to accommodate the block.
2. Place a wood shim of the same or slightly smaller width than the block to be milled (width referring to the dimension being clamped by the vise) onto the inside ledges of the vise.
3. Lay the block to be milled on top of the shim.
4. Line the block up flush with the front of the vise jaws.
5. Use the black-knobbed rod to push the movable jaw of the vise closed.
6. Press the vise clamping lever clockwise all the way to the right to clamp the block in place. This lever should be parallel to the black knobbed rod when in the clamp position.
7. Close the mill doors.

To mill larger blocks, secure the block directly to the table using the same method as that for securing the vise to the table described in "*Install the Mill Vise*".

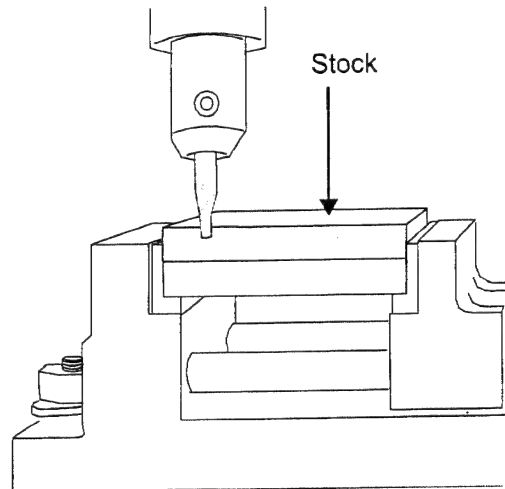
Set the Programmed Reference Zero (PRZ)

Set the programmed reference zero to define the point from which all movements are referenced. Close the mill doors before proceeding.

1. Select Manual from the Main Menu. If the cursor is not next to Manual, use the Z keys to move the cursor to it. Press *ENTER* to select Manual.
2. Using the +X and -X keys, position the center of the cutter over the left edge of the block.
3. Using the +Y and -Y keys, position the center of the cutter over the block.
4. Open the safety doors and cover the block with a 2-inch square piece of notebook paper. Close the safety doors. Using the +Z and -Z keys, position the end of the cutter onto the top of the paper-covered block, adjusting it so that the cutter is touching the paper, but the paper can be pulled free without ripping.

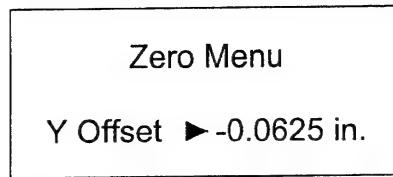


5. Press Zero twice. This sets the PRZ for the X, Y, and Z-axes to the current cutter position. However, because the Y-axis wasn't in the zero position, further adjustment of the PRZ is required.
6. Use the -Y key to move the table back. Use the +X key to move the table to the left and the -Z to move the headstock down so that the cutter is sitting in front of the block with the tip about 1/4-inch below the surface level of the block.



7. Use the +Y key to move the mill table to a position where the cutter is just touching the front of the block.

8. Press *Zero*, *-Y*. The Zero Menu is displayed.

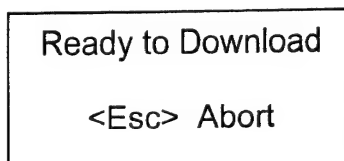


Zero Menu

9. Because the cutter is against the block, a correction must be made to the zero so that it reflects when the center of the cutter is lined up with the edge of the block. To do this, enter one-half of the cutter diameter in decimal form. For example, a 1/8-inch end mill has a diameter of $1/8 = 0.125$ inch. One half of this is 0.0625 inch. Enter .0625 for the Y OFFSET. Press *ENTER*. The Manual Menu is displayed. Ensure that the value of the Y OFFSET is a negative number. If it isn't, repeat this step. The sign is determined by the sign of the Zero Menu access key pressed, e.g., *-Y* indicates that the number entered for the Y offset is negative.
10. Press *+Z* to raise the headstock above the block.
11. Press *ESC* to return to the Main Menu.

Prepare for Part Program Download

Use the *Z* keys to move the cursor to Remote. Press *ENTER* to select the Remote screen. The mill is now ready to accept a program from the computer.



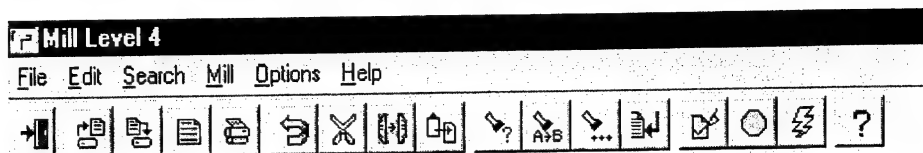
LEVEL 4 SOFTWARE

Start the Software

Click on **Start**. Slide the cursor to **Programs** then **Lab-Volt Apps**.

Click on **Level 4 Mill**.

The Level 4 title screen is displayed, followed soon after by the Main Menu.



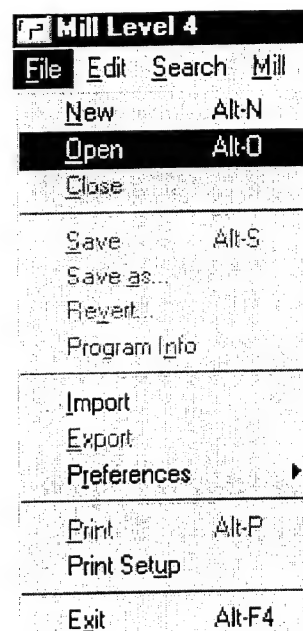
Select the Program, Demo1

Select the **File** menu.

Select **Open**.

Double click on **DEMO1**.

The G and M codes for the DEMO1 part program are displayed.



View Program Information

From the **File** menu, select **Program Info**. This displays the information about the part program selected. Ensure that the part program information corresponds to the equipment and parts provided. Especially note that the measurements are designated in inches and that the block size and material is correct. DEMO1 uses a plastic block 2 inches x 2 inches x 0.5 inches.

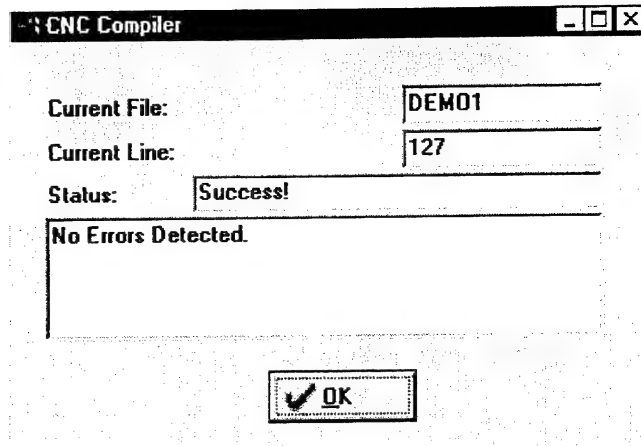
Click **OK**.

Program Name: DEMO1		Revision: A
Author: Lab-Volt Automation		Date: 07/10/98
Drawing ID: 000-1		
Editor: <input checked="" type="radio"/> Line-Mode <input type="radio"/> Block-Mode		
Units: <input checked="" type="radio"/> Inch <input type="radio"/> Millimeter	Stock Size: X: 2 Inch, Y: 2 Inch, Z: 0.5 Inch	
Coordinates: <input type="radio"/> Incremental <input checked="" type="radio"/> Absolute	Material: <input checked="" type="radio"/> Plastic <input type="radio"/> Wax <input type="radio"/> Aluminum <input type="radio"/> Brass <input type="radio"/> Steel <input type="radio"/> Proto-foam <input type="radio"/> Other	
OK		Cancel

Verify that the Part Program is Correct

Select the **M**ill menu.
Select **C**ompile. This is a line by line check of the G and M codes of the program.

Because DEMO1 has been thoroughly pretested, there should be no errors. Click **O**K to close.

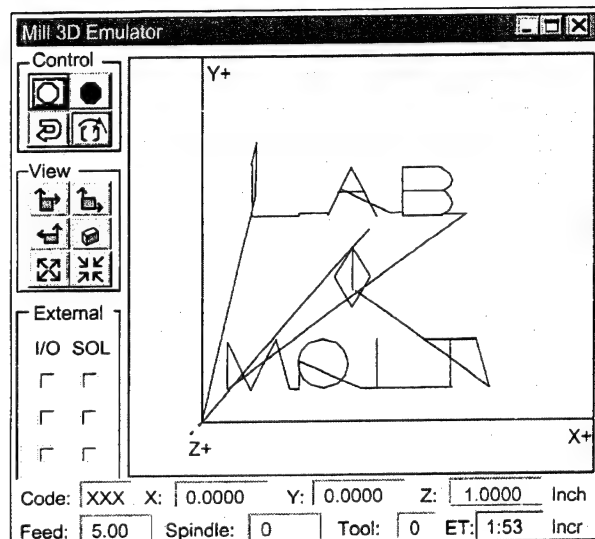


View the Part Emulation

From the **M**ill menu, select **E**mulator.
Click on the green **S**TART button or select **M**ill then **R**un to see the wire frame tracing of the programmed cutter's path.

The red line indicates cutter movements at the programmed rapid movement; the blue line indicates movements at the designated feed rate. The diamond shape indicates the size of the programmed cutter relative to the block.

To select another view, click on one of the options under **V**IEW on the screen.

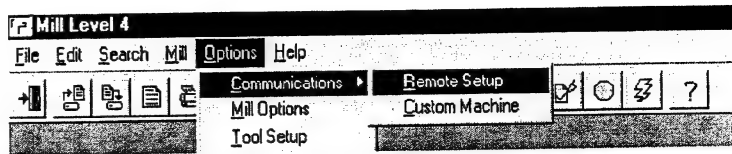


The number following the ET at the lower right of the emulator screen is the approximate time it will take to mill the part.

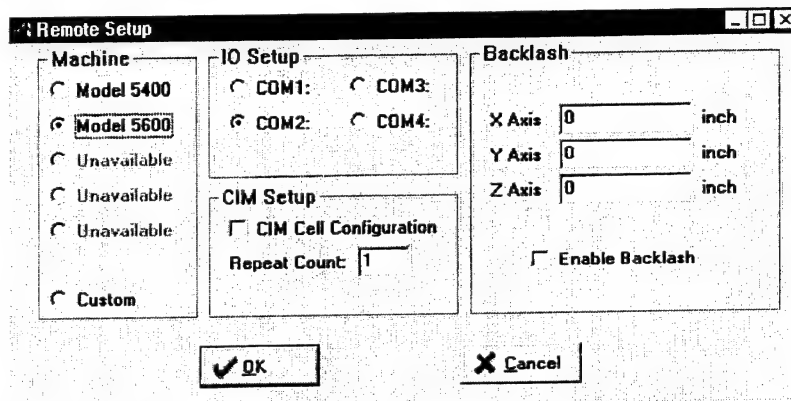
Close the Emulator window.

Check the 5600 CNC Mill Configuration (for first time setup only)

Select the **Options** menu.
Select **Communications**
and then **Remote Setup**.



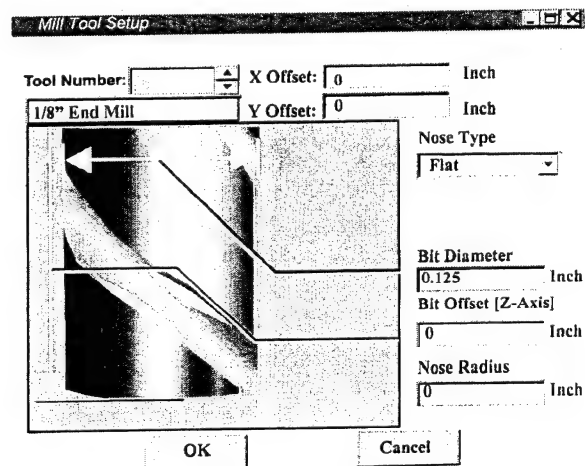
The Remote Setup screen is displayed. Ensure that the equipment described matches the equipment to be used. If it doesn't, change the Machine category so that the description matches the equipment. Also, make sure that the designation of the computer communications port (COM1 or 2) is correct. This is the port for the cable connecting the computer to the mill. "Enable Backlash" should *not* be checked. Click **OK** to exit.



Check the Level 4 Tool Library

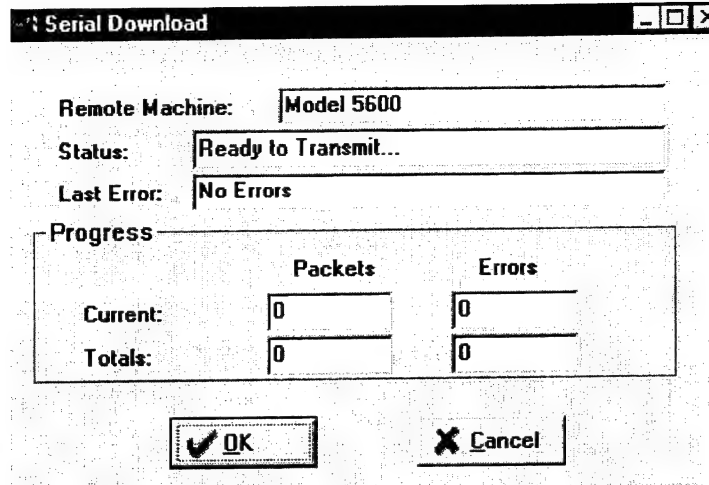
From the **Options** menu, select **Tool Setup**.

Verify that the cutter described is a 1/8-inch end mill cutter with a diameter of 0.125 and a flat nose. It is especially important to confirm that the cutter diameter is correct to ensure the highest degree of milling quality. The X and Y OFFSETS should be zero. If any information is incorrect, enter the correct data. When finished with the screen, click **OK**.



Download the Part Program to the Mill

The system is now ready to mill the part.
From the **M**ill menu on the PC, select **D**ownload.
Click **O**K.



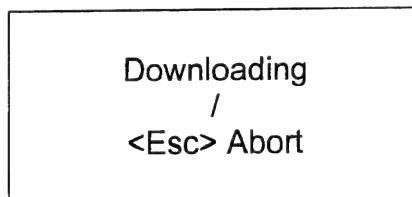
A screenshot of a 'Serial Download' dialog box. It has a title bar with a standard Windows icon and window controls. The dialog contains several fields: 'Remote Machine:' with the value 'Model 5600', 'Status:' with 'Ready to Transmit...', and 'Last Error:' with 'No Errors'. Below these is a 'Progress' section containing a table with two columns: 'Packets' and 'Errors'. The table has two rows: 'Current:' and 'Totals:'. Both rows show '0' in both columns. At the bottom of the dialog are two buttons: 'OK' with a checkmark icon and 'Cancel' with an 'X' icon.

	Packets	Errors
Current:	0	0
Totals:	0	0

Download Screen on the PC

ON THE MILL CONTROL PANEL:

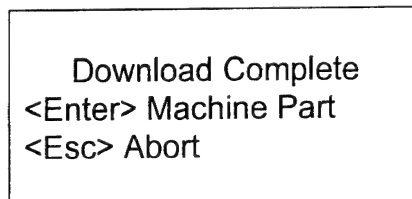
The message "Downloading" with a rotating "/" is displayed.



A rectangular screen display showing the text 'Downloading' followed by a '/' character on the next line, and '<Esc> Abort' on the third line.

Downloading Screen on the Mill

When the Download Complete screen is displayed, press **ENTER**.



A rectangular screen display showing the text 'Download Complete' followed by '<Enter> Machine Part' on the next line, and '<Esc> Abort' on the third line.

Download Complete Screen

If the program is small, the part will be milled. For larger programs, the "Analyzing Program" message is displayed. Press *ENTER* to mill the part.

Analyzing Program
<Enter> Run Program
<Esc> Abort

Analyzing Program Screen

MILL THE PART

If an emergency comes up during the milling process, press the *STALL LIGHT OVERRIDE* switch or the *EMERGENCY STOP* button to stop operations and then refer to **Emergency Procedures**.

After the part program has been successfully downloaded, press *ENTER* to start the run.

At the end of a run, the same part program can be run again simply by pressing *ENTER*. There is no need to download the existing program again.

CHANGE TO A DIFFERENT PART PROGRAM

To select a different program, close the Download window. Click on **F**ile then **C**lose to close the current part program. Click on **O**pen to open a new part program and proceed as previously described.

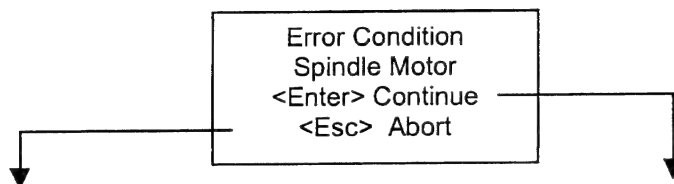
LOAD EXISTING LEVEL 3 PART PROGRAMS

Level 4 Mill software is completely compatible with Level 3 part programs. Use Windows Explorer to copy Level 3 part programs into the Level 4 M4 folder or access the programs directly using **O**pen from the Level 4 **F**ile menu. Either way, change the "Files of type:" to Mill Level 3 Files (*.m3) to access the Level 3 part programs.

EMERGENCY PROCEDURES

STALL LIGHT OVERRIDE Button

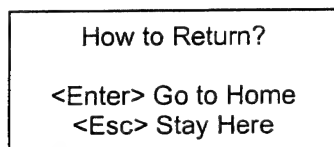
To interrupt the milling procedure because of a mechanical fault such as the cutter coming loose, an inadequately secured block, impending damage to the mill, or an incorrect PRZ setting, press the **STALL LIGHT OVERRIDE** switch. This stops all milling operations immediately and an "Error Condition" message is displayed.



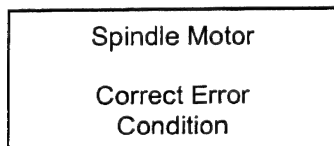
Press **ESC** on the control panel to abort the run.

or

Press **ENTER** to continue.

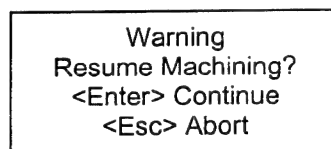
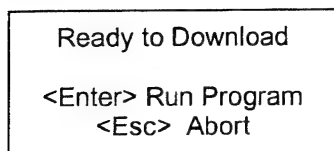


Press **ESC** again to leave the table in its current position or press **ENTER** to return the cutter to its home position, which is one inch above the X,Y coordinates of the PRZ.

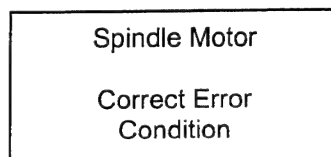


Correct the problem. In most cases the corrective action begins with:

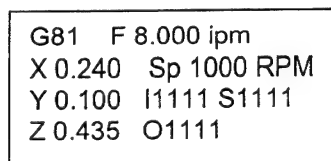
Press the **STALL LIGHT OVERRIDE** then **ESC** to access the Main Menu. Use a **Z** key to move the cursor to Manual. Press **ENTER**. Using the **+Z** key, raise the tool so that the problem can be accessed. When the problem has been corrected, go to **REMOTE** and continue as described in **Mill the Part**.



Press **ENTER** again to continue.



Press the **STALL LIGHT OVERRIDE** to return to the Manual menu and restart the program where it left off.



EMERGENCY STOP Button

Press the *EMERGENCY STOP* button on the lathe control panel to stop all lathe motors immediately. When the problem has been corrected, use the key to unlock the *EMERGENCY STOP* button. Restart operations.

SHUTDOWN PROCEDURE

On the Mill:

When all runs are complete, press *EMERGENCY STOP* on the front panel and turn the power off by pressing down on the power switch on the back panel of the mill.

On the PC:

Close the Download window.

Select **F**ile.

Select **C**lose to close the part program. If changes were made to a part program, a save prompt will be displayed. Indicate whether or not to save the changes.

Select **E**xit. This returns the operator to the Windows desktop screen.

ROUTINE MAINTENANCE

The only routine maintenance required is to clean and lubricate the equipment. After using the mill, clear away all debris using the chip brush or a small vacuum. Clean off the milling table and the Z-axis accordion cover.

The mill should be frequently lubricated with a light machine oil such as 3-IN-ONE® oil. Spread a small amount of oil on the sliding dovetail surfaces of the mill table undercarriage. A cotton swab may be used to help get the oil into difficult to reach areas. After the oil has been applied, set the mill in manual mode and use the X and Y keys to move the axes back and forth to distribute the oil evenly.

Appendix A: Frequently Asked Questions

1. How do you free the axis when it's at its limit?

- ◆ Press *ZERO*, *ESC*. Return to the Main Menu. Select Manual. Use the appropriate X, Y, or Z key to move away from the limit.
- ◆ If the axis is still jammed, press *ENTER* twice from the Manual menu. This puts the system in incremental mode; i.e., pressing the axis key moves it the displayed distance. Refer to **Distance** in **Appendix B: Manual Mode of Operation**. The axis limit switches are disabled in incremental mode so that pressing the appropriate X, Y, or Z key will free the axis.

CAUTION

Be especially careful when in incremental mode! Because the limit switches are disabled, extra care is required to avoid damaging the mill by going past its limits.

- ◆ Press *ESC* to reset the switches.

2. How do you reset the *EMERGENCY STOP* button?

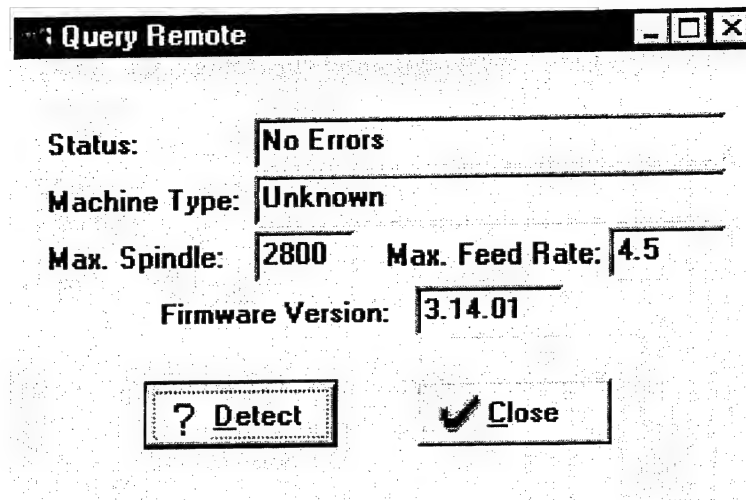
Insert the *EMERGENCY STOP* key in the lock and turn it.

3. How do you choose feed rates and spindle speeds?

The choice of feed rates and spindle speeds depends on the material to be milled and the intricacy or fineness of the pattern to be milled. In general, the harder the surface, the slower the cut must be made and, therefore, the slower the feed rate. The spindle speed must be set fast enough to not leave rough edges, yet slow enough so that the heat generated by the cutting doesn't melt the material being milled.

4. How do you debug communications?

Select Remote from the Main Menu on the mill control panel. On the PC, select the **Mill** menu, then **Query Remote**, correctly and securely.



Status:	No Errors		
Machine Type:	Unknown		
Max. Spindle:	2800	Max. Feed Rate:	4.5
Firmware Version:	3.14.01		

? Detect ✓ Close

Query Remote

Press **Detect** to attempt a connection.

If the connection is correct, the machine type, maximum spindle speed, feed rate and firmware version number are confirmed or updated.

If errors are discovered, here are some suggestions of things to check:

- ◆ Verify that the serial cable is connected properly to both the mill's 9-pin SERIAL INTERFACE port and the computer's 9 or 25-pin communication port.
- ◆ Verify that the computer's communications port being used for cable connection to the mill is correctly designated in the Level 4 Remote Setup screen – for example, if the computer port is labeled COM1, make sure COM1 is selected on the Remote Setup.
- ◆ Verify that the computer serial port is working. Try testing the mouse on that port.
- ◆ In Windows, ensure that the selected communications port is configured as 9600, 8, N, 1.
- ◆ In some cases, old firmware versions can cause communications failure. Ensure that the mill firmware version is 3.02 or higher.

Appendix B: Manual Mode of Operation

In manual mode, all operations of the 5600 CNC Mill can be controlled using the keys on the mill control panel. Manual mode of operation is only available from the Manual menu.

Man R 20.000 ipm
X 0.000 Sp 0 RPM
Y 0.000 I0000 S0000
Z 0.000 O0000

Manual Menu

The first line of the Manual menu is a status line. The “Man” indicates manual mode. The next alphanumeric sequence indicates the feed rate of the mill axis. An “R” indicates that the number following it is the rapid speed. In the example above, the rapid feed rate is 20 inches per minute. This means that the axis will travel at the rapid speed unless another feed rate is entered on the Feed Rate menu (described below under **Feed Rate**).

The numbers following the X, Y, and Z indicate the coordinates of the current position of the three axes (the X, Y table and the headstock).

The “Sp 0 RPM” indicates the current spindle speed.

The lower right of the screen is where the status of the input/output from each of the four TTLs and four solenoids is displayed. These input/outputs are set in the Output menu and the Accessories menu. The four numbers following each letter can be ones (1) or zeros (0). The position of the number within the series indicates which port is displayed; for example, the third number indicates the status of port 3. Zero indicates that the status of the port is low, or not being used. The number “1” indicates that the status is high, or set to be used. The zeros following the letter “I” indicate that the TTL inputs are low; those following the letter “O” indicate that the TTL outputs are low; and those following the S indicate that the solenoid outputs are low.

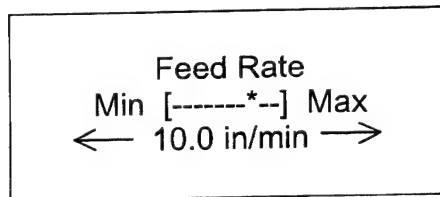
For simplicity when describing feed rates and distances, the mill table and/or the headstock is referred to as the axis. To move the axis, press the key for the direction in which it is to be moved. For example, to move the mill table to the right, press -X. To move the headstock up, press +Z. The table or headstock will move as long as the key is depressed. Optionally, the distance the table or headstock is to move can be set so that each time an axis direction key (e.g., -X) is pressed the axis moves that distance. Refer to **Distance** described below.

ZERO THE MILL

To zero the mill is to tell the mill of the cutter starting point from which all movements are to be referenced. Use the X, Y, and Z keys to position the cutter at the desired starting point and press the Zero key twice to set the zero there. More detailed information is given in the body of this manual under **Set the Programmed Reference Zero**. If, during operations, adjustments to the zero reference must be made, access the Zero Menu by pressing the Zero key followed by the axis key of the direction to be zeroed. Pressing the negative axis key (-X, -Y, -Z) indicates the number to be entered is a negative number. Pressing the positive axis key (+X, +Y, +Z) indicates the number to be entered is a positive number. The number can be entered by pressing the number keys on the control panel and then pressing *ENTER*. The number entered is in the same units as the feed rate: inches or millimeters. If the wrong number is entered accidentally, simply return to the Manual Menu and go through the zero procedure again to enter the correct number.

FEED RATE

The feed rate for manual mode can be set from the Feed Rate menu which can be accessed by pressing the *Feed Rate* key from any menu.



Feed Rate Menu

The Feed Rate menu is a bar menu allowing the feed rate to be set in 1 inch/minute increments by using the -X and +X keys. Press *ENTER* to set the feed rate or press *ESC* to exit the Feed Rate menu without making any changes.

In manual mode, the easiest way to change from the set feed rate to the rapid rate is by pressing *ESC* to return to the Main Menu then *ENTER* to return to the Manual menu which automatically resets the feed rate to R (rapid).

DISTANCE

An axis can be moved the distance determined by (1) the length of time that a direction key is held down or (2) a specified distance can be selected from the Manual menu.

CAUTION

Operating in incremental mode (moving a distance specified in the Manual menu) disables the limit switches. Be careful not to damage the mill by going past its limits.

A selection of distances at the designated feed rate is accessible on the first line of the Manual menu by pressing the *ENTER* key. The first time the *ENTER* key is pressed, the feed rate set in the above Feed Rate procedure is displayed. Each additional time the *ENTER* key is pressed, the distance is displayed and increased by preset increments.

0.020	F	10.000	ipm
X	0.000	Sp 0	RPM
Y	0.000	I0000	S0000
Z	0.000	O0000	

Distance Display in Manual Menu

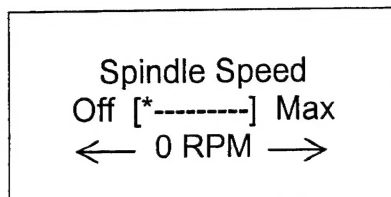
The first number in the line is the distance that the axis will move when the axis direction key is pressed – in the example, two hundredths (0.020) of an inch. The units of the distance are the same as the units displayed for the feed rate. The second number in the line is the rate at which the axis will move. The mill only moves the distance displayed for each key press. For example, if the -X key is pressed while the distance is set at 0.02 inches, the mill table will only move to the right 0.02 inches. To move the table an additional 0.02 inches, the key must be released and pressed again.

Standard (inches)	0.001	0.005	0.010	0.050	0.100	0.500	1.000
Metric (milli-meters)	0.01	0.05	0.1	0.5	1.00	5.00	10.00

Selectable Distances

SPINDLE SPEED

The spindle speed of the mill can be set from the Manual, Setup, or Output menus by pressing the *Spindle Speed* key.

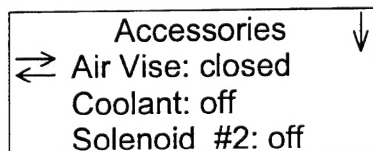


Spindle Speed Menu

The Spindle Speed menu is a bar menu allowing the spindle speed to be set in 100 rpm increments by using the -X and +X keys. The spindle speed increases (or decreases if -X is pressed) each time the +X key is pressed while in this menu. If the Zero key is pressed, the speed drops to zero. Press *ENTER* to set the spindle speed or press *ESC* to exit the Spindle Speed menu without making any changes.

ACCESSORIES

The accessories connected to the mill can also be controlled from the mill control panel. The Accessories menu can be accessed by pressing the Main Menu key from the Manual menu. It allows the user to turn the accessories on or off without leaving the Manual menu. There are four options. Each is a toggle choice selected by pressing -X or +X.



Accessories Menu

The first selection, Air Vise, can be either "closed" (the default status) or "opened". The other three selections, Coolant, Solenoid #2, and Solenoid #3 can be turned "off" (default) or "on".

